THE SUSTAINABILITY OF DUIKER (*CEPHALOPHUS* SPP.) HUNTING FOR THE BAKA HUNTER-GATHERERS IN SOUTHEASTERN CAMEROON

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ABSTRACT Logging operations brought a boom in the bushmeat trade and wildlife management projects into the heart of the forest in southeastern Cameroon. Hunting pressure on duikers (*Cephalophus* spp.) reached an unsustainable level because of the intensified hunting in areas close to roads. Control of the bushmeat trade was then reinforced, and the hunting subsided. The excessive control of hunting, however, could negatively affect the standard of living of the local people because animal meat has long been a major source of protein for forest dwellers in the Congo Basin. Before the opening of logging roads, hunting pressure remained within a sustainable level through an extensive use of hunting grounds covering a large area. Therefore, for the local people to maintain their standard of living, it is essential to grant them the right to consume animals for their subsistence in an extensive manner over a large area, as well as to impose some controls on the bushmeat trade.

Key Words: Bushmeat; Congo Basin; Logging roads; Rainforest; Wildlife management.

INTRODUCTION

The depletion of wild animals is one of the burning issues in tropical deforestation.(1) The expansion of logging operations not only destroys the forest landscape, but also depletes wild animals by facilitating the access of poachers and traders into the heart of the forest. Redford (1992) called forest with depleted fauna "empty forest." Even in uncut forests, animal populations decrease because of the excessive hunting pressure imposed by the commercial trade of bushmeat (meat of wild animals). In most parts of Africa, selective logging is practiced, and thus logged forests are not entirely destroyed. However, satellite images show that logging roads run through most forests, with the exception of those that have been designated as protected areas. Previous studies have argued that countless poachers and traders come and go along logging roads in the Congo Basin to obtain bushmeat, causing hunting pressure to increase to an unsustainable level (Barnes, 2002; Bowen-Jones et al., 2003; Fa et al., 2003; Wilkie & Carpenter, 1999).

Just as the bushmeat trade is being recognized as creating a biodiversity crisis, several wildlife management projects have begun in tropical Africa, including southeastern Cameroon (Ichikawa, this volume). It is undoubtedly important to promote wildlife management. Otherwise, excessive hunting pressure will lead to the rapid depletion of wild animals. Animal meat,

however, has long been an important component of the household economy, and in particular, a major source of protein for forest dwellers in the Congo Basin (Bowen-Jones et al., 2003; Wilkie & Carpenter, 1999). Therefore, the excessive control of hunting could negatively affect the standard of living of the local people. If the local people feel that their standard of living has deteriorated, they may take a rebellious attitude toward management projects. Hattori (in press) argued that the Baka hunter-gatherers, a demographic majority but politically marginalized ethnic group in southeastern Cameroon, do not perceive any benefit from the wildlife management project, and thus show indifference to the concerns of the project.

The literature concerning wildlife management projects always includes comprehensive surveys of large mammal population densities in the project area. Nevertheless, information on the livelihood of the local people often remains ambiguous and insufficient. To develop an effective management plan, it is essential to obtain information on the status of hunting practices for both the bushmeat trade and the subsistence of the local people. Here, I focus particularly on the hunting of duiker (*Cephalophus* spp.), a major source of the daily protein intake of the local people in the Congo Basin (Fimbel et al., 2000; Harako, 1976; Hart, 2000; Ichikawa, 1983; Muchaal & Ngandjui, 1999; Noss, 2000). With the emergence of the bushmeat trade, duiker has also become a principal source of cash. Thus, the hunting sustainability should be examined for both trade and subsistence, with a view to maintaining the long-term standard of living of the local people.

RESEARCH AREA

Field research was conducted in Zoulabot Ancien, located halfway between the two main roads, in Boumba-Ngoko Division, East Province, Republic of Cameroon (Fig. 1). Three large rivers, the Boumba, Bek, and Dja rivers, flow through southeastern Cameroon, which is densely wooded with gently rolling hills at an altitude of 400 to 600 m above sea level. The mean annual temperature is around 25°C, and the temperature remains constant year-round. The annual precipitation at Yokadouma (about 100 km northeast of the study site) was 1291-1680 mm from 1983 to 1993, with an average of 1518 mm (Cameroon Environmental Watch, personal communication). The vegetation around the study area is classified as a mixture of evergreen forest and semi-deciduous forest (Letouzey, 1985).

On the west side of the Boumba River, ten villages are scattered on the route to the Boumba-Bek and Nki national parks (Fig. 2). These villages can be divided into two categories based on population size and composition. In five "Ancien" villages, the Baka people comprise the majority of the population, and a large number of the Konabembe people (Bantu-speaking cultivators[(2)]) live in Malea Ancien, located along the Bek River, which provides good fishing. The cultivators' population sharply increases between Grebe and Biwala I; each

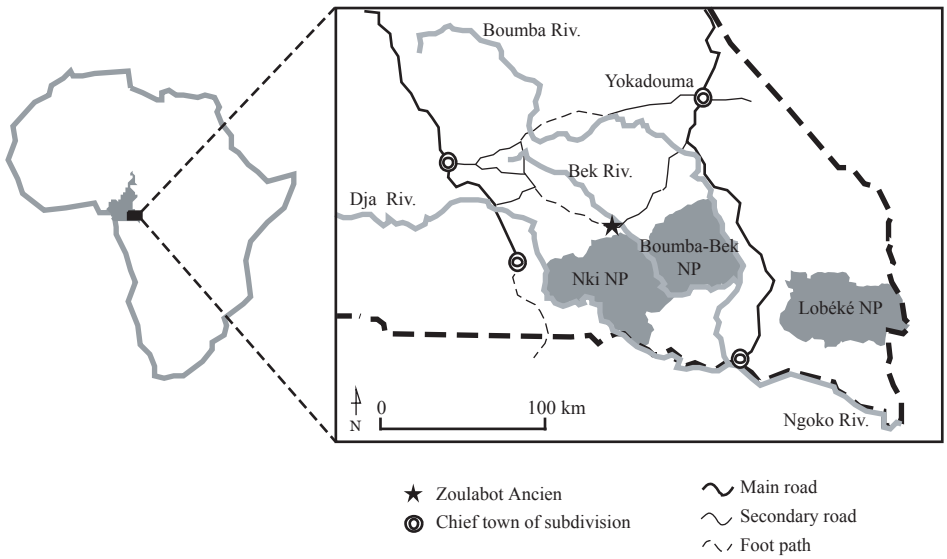
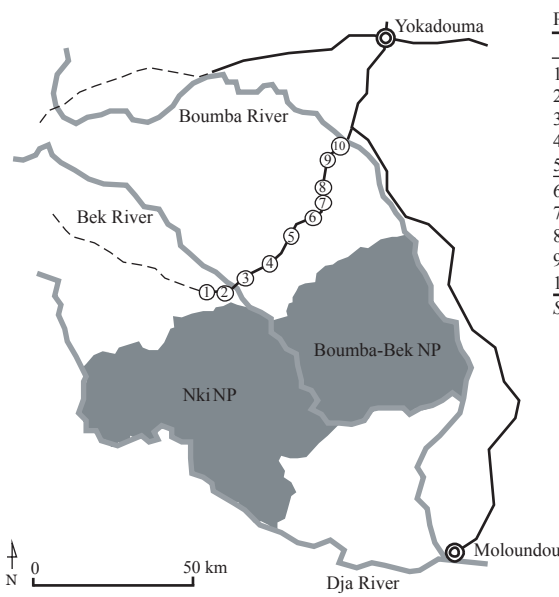


Fig. 1. Research Area (Southeastern Cameroon).



Population in each village.

	Baka	Konabembe	Others
1. Ngato Ancien	242	13	
2. Zoulabot Ancien	152	8	
3. Malea Ancien	184	123	
4. Gouenepoum Ancien	20	5	
5. Som Ancien	95	11	
6. Grebe	600	575	25
7. Bintom	45	105	
8. Zokadiba	560	840	
9. Massea	255	1360	85
10. Biwala I	336	673	673

Source : Halle (2000).

Fig. 2. Locations and Populations of Villages to the north of Boumba-Bek and Nki National Parks.

village, except Bintom, has a population of ≥1000 people, with a large number of Konabembe. This obvious difference in population density implies that the wildlife management plan should be applied flexibly to villages with different demographic characteristics.

Zoulabot Ancien is immediately adjacent to the Boumba-Bek and Nki national parks, in which the residents have customarily searched for wild food, such as yams, nuts, honey, and meat (Yasuoka, 2006). Almost all inhabitants of Zoulabot Ancien are Baka hunter–gatherers. As of April 2005, the total Baka population of Zoulabot Ancien was 143 individuals, comprising 37 households, including four households headed by widows and three temporary households visiting from neighboring villages. Whereas some Konabembe people also lived in the study village, their number at the time was only six. In contrast, 152 Konabembe people lived in the village in 1964 (ORSTOM, 1966), most of whom had migrated in the 1970s to Zoulabot Nouveau and its neighboring villages, which were located in a more convenient area on the east bank of the Boumba River. A *bac* (mobile bridge) over the Boumba River, the only way for vehicles to get to Yokadouma, had been out of order and was only repaired recently. Before the construction of a logging road, vehicles from Yokadouma could only reach as far as the Boumba River, halfway to Zoulabot Ancien. The remaining 80 km had to be covered on foot.

The logging industry grew rapidly after the economic crisis in the late 1980s in Cameroon, and was further stimulated by the devaluation of the CFA franc in 1994 (Eba'a Atyi, 1998). By 1999, 76% of the total forest area of Cameroon had been allocated to logging companies (Bikie et al., 2000). Logging roads were built, connecting the remote villages to the meat-consuming urban areas and logging company bases. One of these reached Zoulabot Ancien in March 2002. Large numbers of people began to use the logging road to reach the village in order to make money selling forest products, which continued even after logging was completed in July 2002.

A wildlife management project in southeastern Cameroon has been promoted by the WWF since 1998 (WWF, 1998). The project covers 2.7 million ha containing 700,000 ha comprising three national parks: Lobéké National Park, established in 2001, and Boumba-Bek and Nki national parks, designated in 2005. This project, named the *Jengi* [(3)] project, has the purpose of attaining sustainable management of biodiversity and improving living conditions for the local people (WWF, 1998). The project grants the local people access to some areas of the national parks to harvest various non-timber forest products (WWF, 1998). Nevertheless, the forestry and wildlife legal regulations prohibit hunting and fishing in national parks, as well as farming, grazing, and forestry (Government of Cameroon, 1994, 1995).

THE BAKA HUNTER-GATHERERS

The Baka hunter–gatherers live in Cameroon, the Congo, and Gabon, and belong to a group of so-called "Pygmies." Their population is estimated at about 25,000 (Joiris, 1998). They speak an Adamaoua East language, whereas most of the neighboring cultivators speak Bantu languages, which belong to a different linguistic family (Hewlett, 1996). A close economic and social relationship nevertheless exists between the Baka and neighboring cultivators, similar to the one found among the Mbuti, the Efe, and the Aka hunter–gatherers living in other parts of the Congo Basin. In the 1930s and 1950s, in compliance with the policy of the French mandate government, and later, the Cameroonian government, the Baka began to reside in semisedentary settlements around the cultivators' villages (Althabe, 1965; Joiris, 1998).

Baka life can be classified into several modes based on their place of residence and method of food acquisition.

A) *Life at the village*: In the village and at farming camps around the village, the Baka cultivate their own fields and depend on plantain banana as their staple food. They sometimes obtain agricultural food from Bantu-speaking cultivators in exchange for labor and bushmeat, but this exchange is not very frequent in the village of Zoulabot Ancien because only a few cultivators live there.

B) *Life at the nearby forest camp* ("ordinary forest camp" in Yasuoka, 2006): In the rainy season, the Baka often make small camps of one to five households at a distance of 10 to 20 km from the village. The main subsistence activity in the nearby forest camp is snare hunting. They carry agricultural food that they grow and purchase to the camps. They gather a variety of wild foodstuff whenever possible; in particular, honey is eagerly sought after.

C) *Life during the long-term foraging expedition* (*molongo*): In the dry season, the Baka form a large group and migrate into the forest for a foraging expedition called *molongo* in their vernacular. Today, the *molongo* is carried out every 2-3 years. The *molongo* camp often consists of ≥10 households, and they stay for ≥2 months at a distance of 20 to 50 km from the village. Throughout this period, they subsist solely on wild food, particularly wild yams (Yasuoka, 2006).

Baka life is mainly composed of life at the village and short stays in forest camps for snaring, with the occasional *molongo*. At other times, for example, men carry out a gun hunting expedition at the request of a gun owner (normally a Bantu-speaking cultivator). Each household can choose any mode of life whenever they want, with the exception of gun hunting expeditions. Also, married women and their husbands often visit their relatives in other villages. Unmarried young men visit other locations seeking potential spouses or to assist with cultivation and odd jobs at the Bantu-speaking cultivators' villages. The period of visiting other nearby villages usually lasts ≤1 month, whereas that of visiting a distant village may extend to 2 to 3 months, or ≥1 year.

Snares made from steel wire are the major method of hunting by the Baka

today. Although Baka men set snare lines even when they stay at the village, snare hunting is more often practiced in the forest camps. When the campsite is decided, women build huts (*mongulu*) of saplings and large Marantaceae leaves. When leaves of Raphia palm are available, men build rectangular huts thatched with them. Men set about ten snares each day. Snares are set along animal trails, 10-30 m apart from each other; sometimes two or three snares are set side by side. Hunters visit their snares every 3 days because trapped animals will spoil within 2 days of death, and they search for honey or hunt animals with spears on the other days. Major game animals of snare hunting are small- to medium-sized ungulates, such as red duikers (*Cephalophus callipygus*, *C. dorsalis*, *C. leucogaster*, and *C. nigrifrons*), yellow-backed duikers (*C. silvicultor*), and bushpigs (*Potamochoerus porcus*). Smaller animals, such as blue duikers (*C. monticola*) and brush-tailed porcupines (*Atherurus africanus*), are also caught with the snares. Larger animals often pull down the snares.

An elderly Baka of about 50-55 years old stated that steel wire was introduced to this area during his childhood (1960s). He also said that formerly, people had made snares with plant materials, but they had hunted animals mainly with spears, rather than snares, and carried out hunting expeditions using only spears in his father's youth. Even today, spear hunting is the predominant hunting method when neither snare wire nor firearms are available. Baka men always carry spears and hunt animals whenever an opportunity arises. The major targets of spear hunting are medium-sized ungulates, such as bushpigs and yellow-backed duikers, and large ungulates, such as African buffalo. Bushpigs are predominantly captured using spears because they live in spottable herds and the animals can be fatally wounded with a single thrust of a spear. In addition, small animals, such as brush-tailed porcupines and mongooses, are sometimes captured with the aid of dogs. In contrast to snare hunting, red duikers are rarely hunted with spears because they live singly or in pairs and are difficult to find.

Harako (1976) wrote that spear hunting held a unique position among the Mbuti. A large animal hunted with the spear provides a large quantity of meat for all the members in a camp, although few hunters are successful. The same can be said for the Baka society. Among the Baka, a hunter who made his first blow with a spear (or today, a gunshot) is prohibited from eating even a single piece of the meat, especially when elephants or bushpigs are hunted. The elders in the hunter's paternal and maternal families are also prohibited from eating the meat. They say that the hunter would never succeed in hunting again, should this restriction be broken. Although the restriction from eating the meat of bushpigs ceases after the hunter has grown up and killed many animals, that for elephant meat is imposed throughout his life.

No one in Zoulabot Ancien, including the Konabembe, owned a gun. An elderly Baka said that he once obtained a secondhand shotgun in exchange for elephant tusks that his mother found in the forest, but this gun malfunctioned at least 15 years ago. Consequently, a gun hunting expedition today is held upon the request of a gun owner, normally Bantu-speaking people living in

Yokadouma or other villages. According to my observations, hunting expeditions differ according to whether the gun is a rifle or shotgun. An average size of a rifle hunting group consists of several adult men with a rifle and spears, and a few boys. It is preferable for a fortune-teller (*nganga*) to join the group. Women remain at the village or in camp. An expedition lasts for 1 to 2 weeks. This massive and somewhat long expedition, with or without a gun, is called *maka* in the vernacular. Rifle owners ask Baka hunters to shoot only large mammals with high returns. Whereas only a small number of animals are hunted with rifles, such animals tend to be large and provide a large quantity of meat. Owners go on the hunting expedition to confirm the firing of the bullets because the Baka hunters sometimes cheat the owners. Baka hunters say that they cannot buy rifle bullets because a bullet costs as much as 12,000 CFA francs (22 US$).

An owner of a shotgun would also ask the Baka to hunt animals with his firearm. Shotgun hunting can be entrusted to a wider range of adult men, whereas rifle hunting is entrusted to a few skillful men. A hunting expedition is carried out by one or a few men over 1 to several days. This small and somewhat short expedition, with or without a gun, is called *sendo* in the vernacular. Baka can buy a cartridge of shot and hunt with a borrowed gun because a cartridge costs only 500 CFA francs (0.9 US$). Major targets of shotgun hunting are monkeys, such as Cercopithecus nictitans, Lophocebus albigena, and Cercocebus agilis. If a hunter finds a bushpig, he approaches stealthily and shoots.

An elderly Baka said that they used to hunt for large animals using the shotgun to fire a spearhead when no rifle was available. According to him, the rifle was introduced to this area a few decades ago, around the time when his 25-30-year-old son was born.

I saw the last remaining crossbow in Zoulabot Ancien. The crossbow was used for shooting monkeys with poisoned arrows, a method practiced even now by the Bantu-speaking people and the Baka in other areas. No one in the village makes crossbows today.

Baka do not carry out net hunting, the predominant hunting method of the Mbuti (Harako, 1976; Ichikawa, 1983; Tanno, 1977) and the Aka (Bahuchet, 1993; Kitanishi, 1995), although Bahuchet (1993) reported that some Baka groups may have practiced this method in the past. An elderly Baka said that he had heard that the Bantu-speaking cultivators formerly conducted net hunting in his father's childhood during the early 20th century. Hunting with a bow and arrows is not carried out among the Baka, which is the predominant hunting method for the Efe (Bailey, 1991; Terashima, 1983). Among the Baka, bows and arrows are usually used by boys to shoot small animals.

METHODS

I. Data

Data were collected during three periods of field research, from August 2001 to September 2002, January to August 2003, and January to March 2005. During the research periods, I observed hunting activities among the Baka and interviewed them about each method of hunting. Geographical information about hunting camps and snaring routes was obtained through GPS data (e-treck, Garmin), transposed on a topographical map (1:200,000 scale) issued by Centre Géographique National de Cameroun. I also recorded the activities and hometowns of each visitor (excluding logging laborers and children) who stayed in Zoulabot Ancien for commercial purposes for ≥1 month between July 2002 and September 2003. In addition, I collected the following quantitative data.

A) *Animals caught with snares*: This investigation was carried out at a *molongo* camp from 9 March to 20 April 2002 (before the logging road opened) and at five nearby forest camps and one snare line around the village from March to August 2003 (after the logging road opened). At the *molongo* camp, I visited all the snare routes with the hunters every week and recorded the animals caught or escaped at each snare. At nearby forest camps, I visited the snaring routes with Baka hunters approximately 2 months after the snares were set, and recorded the species and numbers of animals captured by each snare. Animals were identified with the aid of Kingdon (1997). The capture rate was then calculated by dividing the total number of snare-nights by the total number of captures, representing the number of snare-nights required to capture one animal (Noss, 2000). These data can be considered reliable because the Baka hunters remember precisely the animals that have been caught by each snare.

B) *Amounts of meat and commodities traded at the village*: I employed assistants to record the bushmeat trade in the village from March to August 2003. Whenever they found someone arriving at the village with meat, they recorded the animal species, number of meat units, hunters' names, and meat owners and buyers. To record the amount of commodities imported to Zoulabot Ancien, I provided notebooks to the four traders and had them record their trade performance for 8 months (January-August 2003). In addition, I observed trade and interviewed the people involved at every opportunity.

C) *Density of game animal dung*: This investigation was conducted in February and March 2005, after the bushmeat trade boom during 2002-2004. Two 20×500-m belt transects were established in five plots at 13, 17, 22, 28, and 33 km from the village. I worked with five Baka assistants: one set a 50-m steel tape and the others walked along the belt transect, each in charge of a 5-m width. When animal dung was found in the belt transect, the distance along the transect, the perpendicular distance from the centerline, the name of the animal, and the date of defecation estimated by the Baka, were recorded. Dung density was calculated based on the assumption that all dung in the belt transect was counted, and was not prone to underestimation.

II. Data Analysis

Robinson & Redford (1991) presented a model for calculating the species-specific maximum sustainable harvest levels based on the inherent ability of the species to replace loss. This model quantifies the number of animals expected to join the target population through birth and immigration, labeled the annual maximum production (P_{max}). Maximum annual population growth (λ_{max}) is calculated based on the reproductive parameters of the species, such as age at first reproduction, age at last reproduction, and annual female production. P_{max} is then estimated using population density (D) and λ_{max}, using the following formula:

$$P_{max} = D\ (\lambda_{max} - 1).$$

Robinson & Redford (1991) recommended that for consideration of the potential harvest level, a species' typical longevity should serve as an index of the species' natural rate of replacement by resource competition and predation. They proposed that humans may harvest 60% of P_{max} for very short-lived species (<5 years), 40% for short-lived species (5-10 years), and 20% for long-lived species (>10 years). Thus, the maximum possible sustainable harvest is calculated as follows:

$$P_{RR} = D\ (\lambda_{max} - 1) \times f \qquad (f = 0.2,\ 0.4,\ \text{or}\ 0.6).$$

Animal density (D) was estimated using three variables, dung density (X), daily defecation rate (Y), and dung decay period (Z), following Koster and Hart (1988):

$$D = X/YZ.$$

The values of Y and Z were taken from the literature, estimating the defecation rate at 4.4 pellet groups/day and decay period at 21 days for red duikers (Koster & Hart, 1988), and the defecation rate at 17.45 a day and decay rate ($1/Z$) at 0.0079/day for elephants (Ekobo, 1998).

My investigation of the population density of game animals was conducted in a limited area, although data taken from a large area are required for an accurate estimation of animal population densities. Thus, I evaluated the sustainability of animal harvest following Ekobo (1998), who provided the population densities of large mammals based on 535 km of transects covering the entire area of Boumba-Bek and Nki national parks. In addition, I used Feer (1993), Fa et al. (1995), and Fimbel et al. (2000) for the λ_{max} and longevity of each species.

RESULTS

I. Hunting Practice for Subsistence

In the dry season every 2-3 years, almost all the Baka go on a large and lengthy foraging expedition called *molongo*. In 2002, *molongo* was carried out for 73 nights by 19 households with 89 participants. I use the hunting practice in the *molongo* as a representative case of subsistence hunting among the Baka because *molongo* is carried out far from the village and the participants consume all the game meat in the camp without selling or bartering it with outsiders.

The *molongo* period was divided into two parts: the first part (24 nights, 13 February-8 March), when the party moved every 1 to several days, and the second part (49 nights, 9 March-27 April), when the party stayed at one camp. The number of animals harvested daily during this *molongo* period is shown in Fig. 3. Hunting with spears, machetes, and bare hands occurred throughout the *molongo*, but these hunting methods were more important during the first period than the second. The total number of animals caught using methods other than snares was 19 (14 species) or 16% (=19/116) of the total capture (Table 1). Four bushpigs were caught using spears.

In the second period, when the party stayed at one camp (Fig. 4), the hunting method used was mainly snaring. Twelve men brought pieces of steel wire for snares with them, and seven households without snares received game meat from the snare hunters. Men started setting snares on the day after their arrival. The total number of snares was 200 by the 6th day, 250 by the 12th day, and peaked at 300 on the 26th day. Hence, the number of snares set reached 25 (=300/12) per hunter and 16 (=300/19) per household. Some hunters did not use all the pieces of wire they had carried with them, probably because they expected a harvest large enough for their own needs. Finally, snare hunting was undertaken for 41 nights in the second period, and the total number of snare-nights was 10,192 in the same period. Almost all the snares were set along seven routes stretching in a radial pattern within 3 km of the camp. Considering that the major traveling area in search of honey and animals was within this range, the intensively used area for the *molongo* was estimated at 30 km^2 (=3×3×3.14) at its greatest.

In total, 97 animals (13 species; including six rotten animals) or 84% (=97/116) of the total capture during the entire *molongo* were caught with snares over the 41 nights (Table 1). Consequently, the capture rate (number of snare-nights required to capture one animal) was calculated at 105 (=10,192/97) snare-nights/capture. Seventy red duikers (including five rotten animals), or 72% (=70/97) of all captures, were caught with snares in the *molongo* period; thus, the snaring of red duikers characterized Baka hunting. The number of red duikers extracted from a unit area in this period was calculated at 2.3 (=70/30) individuals/km^2, but this figure is not suitable for assessing the sustainability of their hunting on a long-term basis because it only accounted for one *molongo*

period. The next *molongo* will be carried out in the same region in at least several years. For this reason, the sustainability of subsistence hunting should be discussed later, taking into account the Baka pattern of extensive forest use.

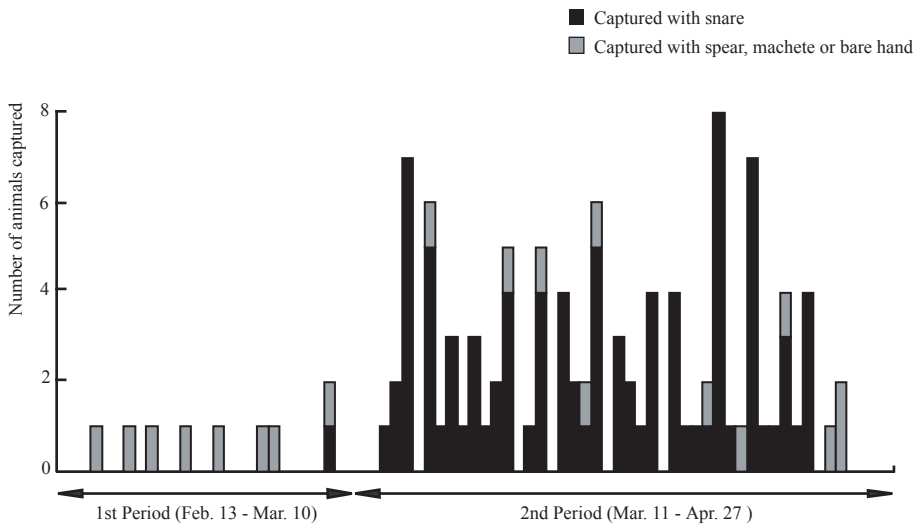


Fig. 3. Daily Number of Captured Animals during the Long-term Foraging Expedition (*molongo*) in 2002.

Table 1. Harvests with Snares and with Other Methods during the *Molongo* in 2002.

Game animals	Snare		Other methods	Total capture
	Capture[a]	[rate[b]] Escape	Capture	
Red duikers[c]	70	[146] 47	1	71
Yellow-backed duiker	10	[1022] 22	1	11
Bushpig	3	[3408] 1	4	7
Large-sized ungulates	3	[3408] 5	1	4
Carnivores	3	[3408] 5	1	4
Primates	3	[3408] 17		3
Blue duiker	2	[5112] 3	1	3
Water chevrotain	2	[5112]		2
Pangolins	1	[10223] 1	1	2
Reptiles			8	8
Rodent			1	1
Total	97	[105] 101	19	116

[a] Including five rotted red duikers and a rotted yellow-backed duiker.

[b] Capture rate is calculated as number of snare-nights divided by the total captures, i.e. the snare-nights required to catch an animal.

[c] Red duikers include *Cephalophus callipygus*, *C. dorsalis*, *C. leucogaster* and *C. nigrifrons*. *C. callipygus* comprised 59% of the total captures of red duikers, and *C. dorsalis* comprised 33% of the total caputures.

II. Aftermath of the Bushmeat Trade in Zoulabot Ancien

Beginning with the construction of the logging road in April 2002, several trucks began to provide transportation services to Yokadouma. Some trucks carried traders almost every day to sell groceries and alcoholic beverages, and the amount of trade increased drastically. After the logging operation was completed in July 2002, 46 visitors stayed for ≥1 month, of whom 42 had come to the village for the first time (Table 2). Twenty-eight visitors were engaged in snare hunting at the Baka hunting camps in the nearby forest. Some hunters came with fishing gear and fished in the Bek River and its tributaries. Nine visitors sold alcoholic beverages, and eight of them were engaged in the bushmeat trade. Some traders also built kiosks to sell groceries.

Snare hunters from other areas can be divided into long-stay and short-stay hunters. Only 4 of 28 visitors stayed in Zoulabot Ancien for ≥1 year. Another 24 part-time hunters snared for 2 to 4 months. Most of the snare hunters came from villages scattered along the way to Yokadouma, and belonged to Konabembe Canton (district) or other cantons of Yokadouma Subdivision. Short-stay hunters visited Zoulabot Ancien after tending cacao fields and clearing their fields of subsistence crops in their own villages; thus, the number of hunters rose beginning in the late dry season (February and March). According to interviews, short-stay hunters came with five rolls of wire on average, which can make 150 (=30×5) snares. When they started snaring, they asked Baka hunters to guide them in the forest. They left the pieces of wire as a reward for their Baka guide when they returned to their own villages and began their agricultural work in July or August.

In contrast, the hometowns of the bushmeat traders were located relatively farther away than those who came to the village to hunt. Some traders were born in western Cameroon and traveled >1000 km to reach the area. The

Table 2. Number and Activities of Visitors Staying for a Month or More from July 2002 to August 2003.

Activities	Visitor arrived before March 2002[a]	Visitor arrived after April 2002
Snare hunting	1	28
Fishing	2	4
Gun hunting (shot gun)	1	2
Gun hunting (rifle and bullets[b])		2
Gun hunting (bullets[c])	2	4
Meat buying	2	8
Alcoholic beverage selling	2	9
Grocery vending	2	3
Farming	1	3
Total number of visitors[d]	4	42

[a] A logging road opened to traffic to Zoulabot Ancien in March 2002.
[b] This number excludes four gun owners who left his rifle to someone at the village.
[c] These visitors provided bullets to the Baka hunters, and borrowed rifles from gun owners.
[d] Excludes children.

traders asked the Baka to increase the number of snares they set. They gave each Baka hunter several rolls of wire (a roll of wire costs 3000 CFA francs [5.5 US$] at Yokadouma), and the Baka gave them five to ten units of smoked meat in return for each roll of wire. The traders continued to deal with the Baka hunter after this initial exchange.

Throughout the research period (March-August 2003), the majority of traded meat consisted of red duikers hunted with snares (Table 3). The total number of meat units of red duiker (one unit equals one flank) was 2817, meaning that about 1400 red duikers were hunted in 6 months. It should be noted that half of the meat sold (1458 units, or 729 animals) was hunted by hunters from other villages in this period. There was also bushmeat of large mammals and primates. Large mammals were hunted by Baka hunters with rifles, which were brought by visitors. Gun holders also gained meat from large mammals, but this figure was excluded because gun holders transported the meat to town on their own. Primates were hunted by both Baka hunters and visitor hunters with their own weapons.

The price of a unit of red duiker meat (one flank) was 500 CFA francs before the logging road opened in 2002, and it rose to 1500 CFA francs after the road opened. The price finally settled at 1000 CFA francs (1.8 US$) in 2003. The retail price at Yokadouma for the same unit was 2000 CFA francs, and 3000 CFA francs at Ngarégombo, on the route to the northern area and the Central African Republic. Given the price of 1000 CFA francs for a unit of meat, red duikers alone brought in 470,000 (=2817/6×1000) CFA francs (850 US$) a month (Table 3). In addition to this, 330,000 CFA francs (590 US$) a month were obtained from other game. Thus, it is estimated that the bushmeat trade in Zoulabot Ancien provided hunters with at least a total of 800,000 CFA francs (1440 US$) a month, half of which went to the Baka hunters.

Each month during the period, an average of 19 Baka hunters sold 227 units of red duikers, which means that 6.0 (=227/2/19) red duikers were captured by each Baka hunter (Table 4). In addition, an average of 14 visitor hunters sold 243 units/month, indicating that 8.7 (=243/2/14) animals per hunter were captured. A Baka hunter thus gained 12,000 (=6.0×2×1000) CFA francs (22 US$) a month on average, and a visitor hunter gained 17,400 (=8.7×2×1000) CFA francs (31 US$). Compared to daily wages for a Baka's labor of clearing the Bantu-speaking cultivators' fields (250 CFA francs), or the season's wages for their assistance in cacao production (10,000-20,000 CFA francs for 3 to 4 months of work; Kagari Shikata, personal communication), the return from snare hunting is fairly good for the Baka, who have few opportunities to earn cash income. The visitor hunters who stayed temporarily in the village likely had other purposes, such as to pass the agricultural off-season, as well as to earn additional money.

The sale of commodities brought into Zoulabot Ancien by four large-scale traders is shown (Table 5). I estimated the total at 1,300,000 CFA francs (2400 US$) per month. This amount exceeds that from the sales of bushmeat, probably because the sale of bushmeat was underestimated. Although the Baka

hunters consumed some meat with their family and bought cloth or cooking pots for their wives with the money earned from bushmeat, a large part of the meat seemed to be exchanged for alcoholic drinks, such as beer, locally brewed spirits made from cassava, and packs of sugary red wine. Consequently, sales of alcoholic beverages accounted for 56% (=1350/2400) of the total sales of commodities that traders brought to the village. An average of 15 bottles of

Table 3. Amounts, Sales and Prices of Bushmeat Traded in Zoulabot Ancien from March to August 2003.

Game animals	Number of traded units		Monthly sales [CFA franc (US$)]	Sales unit	Price at the village
	Entire period	Monthly			
Red duikers [a]	2817	470	470,000 (850)	a flank	1000 (500-1500)
Large mammals	711	119	178,500 (320)	a cut of meat	1500 (1000-2000)
Primates	115	19	57,500 (100)	individual	3000
Blue duiker	42	7	10,500 (20)	individual	1500
Others	77	13	84,000 (150)		
Total			800,500 (1440)		

[a] Red duikers include *Cephalophus callipygus, C. dorsalis, C. leucogaster* and *C. nigrifrons.*

Table 4. Monthly [a] Average of Results of Red Duiker [b] Trade by the Baka Hunters and the Visitor Hunters.

	Baka Hunter	Visitor hunter
Number of active snare hunters	19	14
Number of sold units of meat [c]	227	243
Estimated number of captures per hunter	6.0	8.7
Sales per hunter [CFA franc (US$)]	12,000 (22)	17,400 (31)

[a] Data were collected from March to August 2003.
[b] Red duikers include *Cephalophus callipygus, C. dorsalis, C. leucogaster* and *C. nigrifrons.*
[c] Sales unit of red duikers is a flank, normally sold at 1000 CFA francs (1.8 US$).

Table 5. Monthly Sales of Commodities Imported to Zoulabot Ancien by Four Large-Scale Traders from January to August 2003.

Commodity	Monthly Sales [CFA franc (US$)]	Amount	Price at the village [CFA franc]
Alcoholic beverages	732,400 (1350)		
Beer	323,000 (600)	430 bottles	700-800/bottle
Spirits of cassava (locally made)	320,500 (590)	400 L	800/L
Red wine	88,900 (160)	60 packets (liter)	1500/L
Starchy food	339,000 (620)		
Cassava flour	264,700 (480)	520 kg	500/kg
Rice	61,800 (120)	120 kg	500/kg
Others	12,600 (20)		
Oil and fat, seasoning, etc.	80,000 (160)		
Clothing	74,700 (140)		
Others	76,300 (140)		
Total	1,302,400 (2400)		

beer and 15 L of local spirits were consumed each day in the village. Selling these drinks to the Baka is the most popular method for traders to retrieve the money spent on meat.

Cassava flour was another major commodity, accounting for 20% (=480/2400) of the total sales of commodities. This commodity is used to encourage hunting activities. Traders gave 10 kg of cassava flour to hunters going to the forest camps, and the hunters paid it back with meat. Traders often carried bags of cassava to hunting camps and exchanged them for meat. As a result, most of the money in the Zoulabot Ancien economy circulated in the trade of bushmeat and alcoholic drinks/cassava flour. Moreover, it should be noted that the money flow from the bushmeat trade provoked countless squabbles among the drunkards, rather than improving their standard of living.

III. Hunting during the Bushmeat Trade Boom

During the bushmeat trade boom, most animals were hunted at the nearby forest camps. In the research period (July 2002-August 2003), 35 camps were built by the Baka, some of which were also used by visitor hunters from other villages and others solely by the Baka. These camps consisted of an average of 2.5 Baka households. All camps, except one, were located in the southern part of the forest within an area of 350 km^2 (Fig. 4). A stay at a camp lasted for an average of 60 days, and the total camp-months for the research period (14 months) was 75, meaning 64 (=75×12/14) camp-months/year (Table 6).

The results of snare hunting at the village site (V site) and at five nearby forest campsites (NF sites 1-5) set up by the Baka hunters during the bushmeat trade boom are shown in Table 5. The composition of game animals at each site was similar. Red duikers comprised an average of 79% (=23/29) of the total number of animals caught with snares at the V site, and 73% (486/662) at the NF sites. This figure was very similar to that recorded at the *molongo* campsite (72%; M site; Table 1). In addition to red duikers, 43 bushpigs, 35 blue duikers, and 34 yellow-backed duikers were captured. The average capture rate at the NF sites was estimated at 121 (=80,299/662) snare-nights/capture, which again, was similar to that at the M site (105; see Table 1). However, that at NF site 1 was exceptionally high (286), which implies an extremely low harvest rate. This was probably because the high hunting pressure had depleted animals in the forest along the Lebe River just 5 km south of the village. Apart from this, no appreciable difference was seen among the four sites in terms of game composition or capture rate, indicating that the game population of the forest had not been gravely depleted as of 2003. However, this does not ensure the sustainability of hunting.

In contrast to the similarity in the capture rates, the average number of snares set per household at the NF sites (74) was remarkably high compared to that at the M site (16). Some Baka hunters set as many as 150 snares at NF sites. This undoubtedly resulted from arrangements with the bushmeat traders. As a result, the average daily harvest per household increased from 0.15

(=16/105, M site) to 0.61 (=74/121, NF sites) individuals/household-day. If they used the same quantity of meat for their own consumption as at the *molongo* camp, they could sell three of four game animals captured during the bushmeat trade boom.

Fig. 4. Location of Nearby Forest Camps Built during July 2002 to August 2003.
Twenty-seven camp sites are shown in this figure. Six camps were used twice. The location of 19 camps were confirmed with GPS, eight camp locations are estimated from interviews, two camp locations could not be estimated although they are in the heart of the camp distribution.

Table 6. Monthly Change of Number of Camps of the Baka Hutners.[a]

2002						2003								Total number of camp-month
Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	
1	4	7	2	5	4	9	9	2	3	6	9	9	5	75 (64/year)

[a] Camps in which the Baka hunters stayed on the firtst day of each month were counted.

Table 7. Numbers of Captures with Snares at the Village Site and Nearby Forest Sites.

	Village	Nearby forest camp						
	V Site	NF Site 1	NF Site 2	NF Site 3	NF Site 4	NF Site 5	Total	
Game animals / Distance from the village		8 km	9.5 km	18 km	19 km	21.5 km	Capture	[Rate]
Red duikers [a]	23	24	117	172	121	52	486	[165]
Bushpig	1	2	6	10	15	9	42	[1912]
Blue duiker		8	5	8	14		35	[2294]
Yellow-backed duiker		1	5	16	9	3	34	[2362]
Primates			2	6	14	1	23	[3491]
Carnivores	2	1	3	9	7	1	21	[3824]
Large-sized ungulates			1	3	3		7	[11471]
Water chevrotain	1	1				4	5	[16060]
Pangolins		1	2	2			5	[16060]
Rodents	2		2		2		4	[20075]
Total capture [Capture rate [b]]	29 [132]	38 [289]	143 [133]	226 [110]	185 [82]	70 [148]	662	[121]
Number of hunters	1	3	3	5	2	2	2.7 (per site)	
Number of snares set per hunter	38	49	82	78	104	61	74	
Days [months] of snaring	104 [3.5]	79 [2.6]	85 [2.8]	71 [2.4]	83 [2.8]	91 [3.0]	409	[13.6]
Number of snare-nights [c]	3826	10965	19014	24840	15141	10339	80229	

[a] Red duikers include *Cephalophus callipygus*, *C. dorsalis*, *C. leucogaster* and *C. nigrifrons*. *C. callipygus* comprised 83% of the total captures of red duikers, and *C. dorsalis* comprised 14%.

[b] Capture rate is calculated as Number of snare-nights divided by the total captures, which means the snare-nights required to catch an animal.

[c] Number of snare-nights was estimated on the assumption that a hunter set five snares a day from the beginning of the stay.

IV. Game Densities after the Bushmeat Trade Boom

By January 2005, 2 years after the beginning of the bushmeat trade boom, control over bushmeat trade had been greatly strengthened. Vehicles from the wildlife management agencies came to the village every week to stop the meat trade, and consequently, the bushmeat trade boom cooled down. Since the ban of the bushmeat trade, the Baka have been hunting animals only for their own consumption.

An investigation of game densities was conducted for this situation (Table 8). Counts of elephant dung were highest because the dung is massive and decays slowly, although it was concentrated in the remotest area. The second highest was dung of red duikers. Counts of dung of every animal, except bushpigs, were smaller in plots I, II, and III in the area that had been used in the intensive hunting for the bushmeat trade, and larger in plots IV and V, which were outside that area (Fig. 4). This implies that as a whole, the game densities were lower in the area close to the village. The question is whether this difference in game densities was caused by the bushmeat trade, which I will discuss below.

Population densities in the total area of dung-count plots were estimated at 8 (=74/4.4/21×10) individuals/km^2 for red duikers and 0.4 (=94/17.45×0.0079×10) for elephants, which correspond well to Ekobo's (1998) estimation of 5.3 to 11 and 0.1 to 0.6 individuals/km^2, respectively. Observations of the dung of other game animals were too few to reliably estimate the population densities in the area.

In addition to snare hunting, the bushmeat trade boom also stimulated gun hunting. Only a few gun owners came to the study area because there were not many experienced big game hunters (*tuma*). However, I counted gun hunting expeditions at least 20 times during January-September 2003, and suspect that about half of them were successful. Although I could not obtain reliable data on gun hunting because it was often practiced surreptitiously, I believe that the effect of gun hunting on elephant density may have been considerably high.

Table 8. Number of Droppings and Population Density Estimates in Each Plot.[a]

Plot (Distance from the village)	I (13 km)	II (17 km)	III (22 km)	IV (28 km)	V (33 km)	Total
Total number of droppings						
Elephant		15	9	14	56	94
Red duikers [b]	7	9	13	26	19	74
Bushpig	4	1	2	3	4	14
Yellow-bucked duiker			3	7	2	12
Blue duiker		1		3	2	6
Others	3			5	9	17
Total	14	26	27	58	92	217
Density estimate[c] (ind./km^2)						
Red duikers	3.8	4.9	7.0	14	10	8.0
Elephant	0	0.3	0.2	0.3	1.3	0.4

[a] Two 20 × 500−m (1 ha × 2) transects were set in each plot, after the bushmeat trade boom.
[b] Red duikers include *Cephalophus callipygus, C. dorsalis, C. leucogaster* and *C. nigrifrons*.
[c] Variables for estimation were taken from Koster & Hart (1988) and Ekobo (1995), see methods.

DISCUSSION

Whereas the Baka hunt a variety of game animals[4] using several methods, I focus here on the sustainability of duiker hunting with snares, which is very important to the Baka livelihood. As mentioned above, species-specific maximum possible sustainable harvest levels (P_{RR}) can be calculated using the formula:

$$P_{RR} = D\ (\lambda_{max} - 1) \times f \qquad (f = 0.2,\ 0.4,\ \text{or}\ 0.6).$$

According to Ekobo (1998), who presented data on population densities of large mammals in Boumba-Bek and Nki national parks and adjacent areas,[5] the density (D) of red duikers was estimated at 5.3-11 individuals/km^2, that of blue duikers at 0.1-3.7 individuals/km^2, and that of yellow-backed duikers at 0.85-1.7 individuals/km^2. Here, I use both Ekobo's (1998) and my estimations (Table 8) to calculate the maximum sustainable annual harvest. The literature provides different values of the annual maximum population growth rate (λ_{max}).

Feer (1993) reported a λ_{max} of 1.65 for red duikers, 2.33 for blue duikers, and 1.39 for yellow-backed duikers. Fa et al. (1995) gave a λ_{max} of 1.54 for red duikers, 1.63 for blue duikers, and 1.54 for yellow-backed duikers. Fimbel et al. (2000) presented the lowest values of λ_{max} at 1.24 for red duikers and 1.63 for blue duikers.

Both Fa et al. (1995) and Fimbel et al. (2000) recognized that both red and blue duikers fall into the "short-lived" category and yellow-backed duikers into the "long-lived" category. Therefore, according to the proposition of Robinson & Redford (1991), 0.4 (=f) of the annual maximum production of red duikers and blue duikers, and 0.2 (=f) of that of yellow-backed duikers can be extracted as the sustainable harvest over the long term.

Substituting these values into the formula estimates the maximum sustainable harvest of red duikers at 0.5 [=5.3×(1.24–1)×0.4] to 3 [=11×(1.65–1)×0.4] individuals/km^2/year (Table 9). The maximum sustainable harvest was estimated at 0.03-1 and 0.07-0.2 individuals/km^2/year for blue duikers and yellow-backed duikers, respectively. These values were hereafter used to evaluate the

Table 9. Density [D], Annual Increase Rate [λ_{max}], Sustainable Extract [f_{RR}], and Sustainable Harvest Level [P_{RR}] of Duikers.

Game animals	D [a] (ind/km^2)	λ_{max} A[b]	λ_{max} B[c]	λ_{max} C[d]	f_{RR} [e] (Longevity[bc])	P_{RR} (ind./km^2/year) [f] on λ_A	on λ_B	on λ_C
Red duikers [g]	5.3 - 11	1.65	1.54	1.24	0.4 (8 year)	1.5 - 3	1 - 2.5	0.5 - 1
Blue duiker	0.1 - 3.7	2.33	1.63	1.63	0.4 (7 year)	0.05 - 1	0.03 - 0.9	0.03 - 0.9
Yellow-bucked duiker	0.85 - 1.7	1.39	1.54	n/a	0.2 (10 year)	0.07 - 0.1	0.09 - 0.2	n/a

[a] Ekobo (1998).
[b] Feer (1993). Conversed intrinsic rates of natural increase (r) into λ by following formula: $\lambda = e^r$.
[c] Fa et al. (1995) based on Payne (1992).
[d] Fimbel et al. (2000) based on Von Ketelhodt (1977), Feer (1988), Payne (1992) and Koster & Hart (1998).
[e] Robinson & Redford (1991).
[f] P_{RR} is calculated by following the formula: $P_{RR} = D\ (\lambda_{max} - 1)\ f_{RR}$ (Robinson & Redford, 1991).
[g] Red duikers include *Cephalophus callipygus, C. dorsalis, C. leucogaster* and *C. nigrifrons*.

sustainability of hunting.

With the bushmeat trade, a total of 28 visitor hunters arrived at Zoulabot Ancien in 2002-2003 and the number of snares set by the Baka hunters increased by more than four times, from 16 to 71 per household at the forest camps. Once the snares have been set, the hunters can expect continuous harvests for 2 to 3 months with only the light labor of checking the snares every 3 days, which can be managed by boys or women. This means that when the forest is abundant with animals, the upper limit of animal captures is set only by the total number of snares. In this situation, the scale of snare hunting can be sharply enlarged with wire supplies and meat demand. The logging road actually brought in traders with hundreds of liters of alcoholic beverages, and took out hundreds of units of bushmeat to the market (Tables 3 & 5).

In the period of the bushmeat trade boom, 35 snare hunting camps were built in an area of 350 km^2 within a radius of 20 km from the village (Figs. 4 & 5) because the hunters can easily go to the village from the camps to sell meat and bring food back. At five NF sites, which were used for a total of 13.6 camp-months, 486 red duikers in total were captured (Table 7). The total annual (for 64 camp-months/year, see Table 6) harvest of red duikers by the Baka was thus estimated at 2287 (=486×64/13.6) animals. The harvests of visitor hunters, which amounted to as many as the Baka hunters (Table 4), should also be counted. Therefore, we can roughly estimate the annual extraction of red duikers in Zoulabot Ancien at about 4500 (=2287×2) animals.

The annual extraction can be also estimated from the trade record and the capture rate. The Baka and visitor hunters in Zoulabot Ancien sold a total of 2800 (=1400×2) red duikers/year (Table 3). This record indicates that each Baka hunter captured 6.0 red duikers/month (Table 4). However, each Baka hunter set an average of 74 snares, and the capture rate was estimated at 121 snare-nights/capture, meaning that each Baka hunter captured 18.3 (=74×30/121) animals/month (Table 7). Considering these figures, the trade record should be modified to estimate the maximum possible annual extraction, which was calculated at about 8500 (=2800×18.3/6.0) animals.[6]

Hence, the annual extraction of red duikers per unit area during the bushmeat trade boom was 13 (=4500/350) to 24 (=8500/350) individuals/km^2/year, which substantially exceeds the highest estimation for their maximum sustainable harvest (3 individuals/km^2/year). In addition to red duikers, 35 blue duikers and 34 yellow-backed duikers were hunted at five NF sites. Under the same assumptions as for red duikers, the total annual harvest of both blue duikers and yellow-backed duikers was 320 (=4500×35/486) to 610 (=8500×35/486) animals from the 350-km^2 area. The annual extraction of these duikers is thus calculated at 0.9 (=320/350) to 1.7 (=610/350) individuals/km^2/year, which matches or exceeds the highest estimation for the maximum sustainable harvest of blue duikers and yellow-backed duikers (1 and 0.2 individuals/km^2/year, respectively).

Such high hunting pressure as that observed during the bushmeat trade boom would not be sustainable over the long term. As of 2005, game densities

decreased with increasing proximity to the village (Table 8). In contrast, the game population around the NF sites, except for NF site 1, would have remained abundant enough to sustain the high capture rate as of 2003 because the capture rates at four NF sites remained at the same level as that during the *molongo* camp. Moreover, Ekobo (1998), who surveyed animal population densities in this area before the bushmeat trade, showed only a very weak relationship (r^2=0.05) between densities of red duikers and the distance to the nearest village. It is thus concluded that the decrease in game densities were caused by increased hunting pressure during the bushmeat trade boom.

According to the Baka hunters, control on hunting and trade has been greatly strengthened since 2004. It is reasonable to control the bushmeat trade to maintain the standard of living of the local people; otherwise, the game animals would soon be depleted because of overhunting. However, the question remains whether the local people would have depleted the game population when they were hunting principally for their own consumption in an extensive manner over a wide area.

The total number of animal harvests in the *molongo* period amounted to 116 animals, of which 71% (82 animals) were duikers captured solely using snares (70 red duikers, 10 yellow-backed duikers, and 2 blue duikers; see Table 1). These animals were consumed by 89 people in 50 days. Extrapolating these figures to the total population of the Baka in Zoulabot Ancien (143 people), the annual duiker harvest can be estimated at 821 (=70×143/89×365/50) red duikers, 117 (=10×143/89×365/50) yellow-backed duikers, and 23 (=2×143/89×365/50) blue duikers.

The practical area used by the people of Zoulabot Ancien was estimated by Yasuoka (2006). The people used a large area of forest to the south of the village, in particular, the forest along the west side of the Bek River, which had abundant wild yams (Fig. 5; Yasuoka, 2006). This area comprises about 1000 km^2, in which they usually build camps for hunting and gathering purposes. Thus, the population density is calculated at 0.14 (=143/1000) people/km^2, taking into account their long-term livelihood.

An average annual extraction of duikers on a long-term basis was estimated as follows: 0.8 (=821/1000) individuals/km^2/year for red duikers, 0.02 (=23/1000) for blue duikers, and 0.1 (=117/1000) for yellow-backed duikers (Table 10). Whereas the figures for red duikers and yellow-backed duikers somewhat exceed the lower estimations for the maximum sustainable harvest (0.5 and 0.07 individuals/km^2/year, respectively), they are half to one-third of the higher estimations (3 and 0.2 individuals/km^2/year, respectively); that of blue duikers is below the lower estimation (0.05 individuals/km^2/year). In conclusion, no evidence exists to support the idea that subsistence hunting by the Baka depletes duiker populations.

During the *molongo*, when they are self-sufficient, the Baka set a moderate number of snares around the *molongo* camp. During the *molongo* period, meat supplied an average of 0.36 kg of edible animal meat per adult-day (Yasuoka, 2006). Robinson & Bennett (2000) estimated that it is necessary to take 0.28

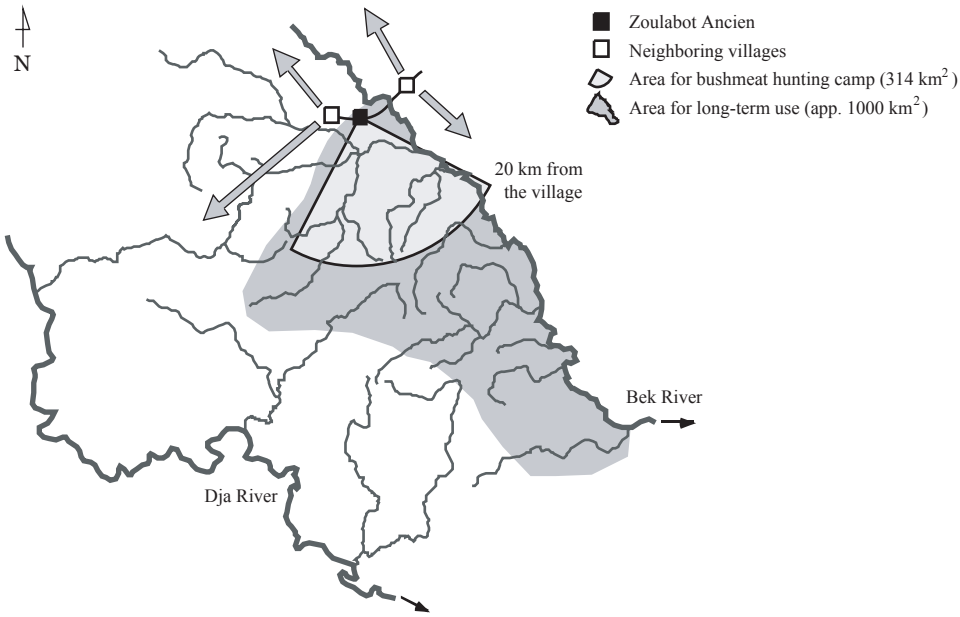


Fig. 5. Area for the Bushmeat Hunting and Long-term Use by the Baka in Zoulabot Ancinen.

Table 10. Annual Extraction Rate of Duikers from the Hunting Area and Maximum Sustainable Harvest (P_{RR}).[a]

Game animals	Annual extraction rate (ind./km^2/year)		P_{RR} (ind./km^2/year)
	Subsistence hunting [b]	Bushmeat trade hunting [c]	
Red duikers[d]	0.8	13 - 24	0.5 - 3
Blue duiker	0.04	0.9 - 1.7	0.05 - 1
Yellow-bucked duiker	0.1	0.9 - 1.7	0.07 - 0.2

[a] See Table 9.
[b] Subsistence hunting is practiced in an area of 1000 km^2.
[c] Bushmeat trade hunting is practiced in an area of 350 km^2.
[d] Red duikers include *Cephalophus callipygus, C. dorsalis, C. leucogaster* and *C. nigrifrons.*

kg of meat per day if protein intake depends solely on animal meat. Therefore, the actual yield from hunting during the *molongo* is 130% (=0.36/0.28) of the recommended daily meat intake.

If the total population of the Baka in Zoulabot Ancien acquires exactly the recommended amount of meat throughout the year, 630 (=821/1.3) red duikers a year must be hunted. If they hunt this number of animals at a level below the lower estimation of the maximum sustainable harvest (0.5 individuals/km^2/year), they need an area of 1260 (=630/0.5) km^2. Although this is a rough estimation, it clearly indicates that the Baka can obtain the minimum recommended daily amount of protein on a sustainable basis only through the extensive use of a large area. In other words, hunting pressure would certainly rise far above the sustainable levels if the Baka acquire the recommended amount of meat in a much smaller area.

CONCLUSIONS

Newly opened logging roads allowed visitor hunters and traders to reach the interior forest, carrying the cash economy with them, and thereby provided channels to connect Baka life with the wider regional economy. A boom in the bushmeat trade was triggered, and it affected hunting in Zoulabot Ancien. The game population of the forest did not seem to have been seriously deteriorated as of 2003, as shown by a capture rate that had not decreased significantly (from 105 to 121 snare-nights/capture). However, the number of snares set by the Baka hunters increased by more than four times (from 16 to 74), and they hunted four times more animals than they did before the boom (from 0.15 to 0.61 individuals/household/day). The estimated annual harvest of red duikers in Zoulabot Ancien increased from 800 to 4500-8500 individuals/year, half of which were hunted by visitor hunters. Moreover, many hunting camps were built in a small area near the village (350 km^2 compared to 1000 km^2 previously). Therefore, the annual extraction of game animals per unit area increased dramatically (from 0.8 to 13-24 individuals/km^2/year for red duikers), and the hunting pressure must have exceeded the sustainable level. The game population would have been depleted if the hunting pressure had remained at such high levels.

During the bushmeat trade boom, most of the harvest was sold to traders. Moreover, a considerable part of the money the Baka gained from selling meat was spent on alcohol, which caused countless squabbles. Control of the bushmeat trade was then reinforced. Because of this strict control (the ban on commercial bushmeat trade in the area), bushmeat hunting subsided. Once the road was deserted, it was soon overtaken by plants. In January 2005, all traders had left the village, except for one who only bought fish, which was not prohibited; thus, the Baka returned to hunting animals only for their own consumption.

The need for some type of control over the bushmeat trade has become inevitable. However, I would like to emphasize that the residents of Zoulabot Ancien have customarily been hunting animals on a sustainable basis in a large area, and that the forest fauna can sustainably provide the people with sufficient protein only when it is exploited in an extensive manner over a large area. Moreover, the Baka cannot readily obtain an alternative source of protein from livestock or fish. This situation must be considered by the *Jengi* project, which includes the objective of improving the living conditions of the local people.

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NOTES

(1) Tropical deforestation has been progressing worldwide at a rate of 10.2 million ha/year, and 154 million ha (8.3%) of the tropical forests of the world were lost during the period from 1990 to 2005 (FAO, 2005). In Cameroon, 3.3 million ha (13.4%) of the rain forest has been lost over the last 15 years (FAO, 2005).

(2) Here, I use the term "Bantu" to refer to the non-Baka inhabitants, although a few groups of Adamaoua East-speaking cultivators exist.

(3) *Jengi* is the most powerful spirit of the Baka hunter-gatherers (Tsuru, 1998).

(4) The maximum sustainable harvest for bushpigs, the second most captured game animal, can be estimated as higher than that for duiker species because bushpigs have a relatively high reproductive ability (λ_{max} =2.01; Fa et al., 1995).

(5) These figures represent the game densities in the forests adjacent to the study site, including the Boumba-Bek, Nki, Corridor, and North Nki forests. Ekobo (1998) also conducted an investigation in a wider area, including the Ngoila, Moloundou-Mimbomimbo, and Ndongo-Adjala forests.

(6) This number is certainly overestimated because the capture rate must decline as the animal populations are depleted.

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